

DEMAND FOR AND SUPPLY OF PRICE INFORMATION IN MARKETS FOR CONSUMER GOODS

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I. *Introduction*

Information has recently become the center of public attention in Japan. Obviously, the recent rapid progress in the computer and communication technology is the direct factor for this phenomenon. But the fact that our society is becoming increasingly complex is also an important factor. In the field of economic science, systematic analysis of information started as early as twenty years ago. In contrast to the perfect information assumption in the general equilibrium theory [e.g. Debreu (1959)], some economists became aware of the scarcity of information in the real economy. Since information is valuable but scarce, it must be produced with costs. If perfect information is not available without prohibitive costs, most commodity markets may significantly diverge from perfect competition, as far as the society's resources are limited. The primary task of this paper is to investigate a method of information production and dissemination, which will be very powerful in the computer age.

For the purpose of exposition we confine our analysis to markets for consumer goods in this paper. We would like to consider the information that is useful to consumers in these markets. Such information can be classified into three types. The first is about commodity qualities (or attributes). The second is about commodity prices (or transaction conditions). And the third is about when and where commodities are available. Though the second and the third types of information are purely objective, the first type is partly objective and partly subjective. We are interested mainly in objective information in this paper.

There are many different conventional methods of information production and dissemination in markets for consumer goods. The most fundamental method is for sellers to display goods for sale. This is sometimes accompanied by explanations by sellers. In order for this method to be effective, consumers have to search actively at their expense [Stigler (1961), McCall (1970)]. Sellers' display together with consumers' searches can produce as 'direct' information some amount of the three types of information mentioned above. But according to Nelson's (1970) terminology, the information about qualities produced by this method is only about search qualities, i.e., qualities that can be observed before purchase. Information about experience qualities can be obtained only after consumption. There is a possibility that this method also produces 'indirect' information. From how crowded each store is consumers can infer to some extent how other consumers evaluate the commodities it

sells. Klein and Leffler (1981) point out that consumers can acquire information about commodity qualities from sunk firm-specific assets, which will bring about losses to sellers that supply low quality commodities because consumers' repeat purchase will cease. This fundamental method works well only when consumers' search costs are low or when markets are relatively simple.

Another (very popular) method of information production and dissemination is advertising [e.g. Butters (1977)]. Economic analysis of advertising has recently developed a great deal. Though this method enables sellers to convey various kinds of information, it has some problems. The direct information conveyed has a problem of credibility, and it contains only what sellers chose to convey. Further, the fact that consumers do not face directly the advertised commodities sets a limit to the effectiveness of this method. Some point up an indirect role of advertising rather than the direct one [Nelson (1974), Kihlstrom and Riordan (1984)]. A large amount of advertising expenditures of a seller may imply a high quality of its commodity, because otherwise consumers' repeat purchase ceases and advertising costs cannot be recovered. We can also apply the above-mentioned theory of sunk firm-specific assets to advertising.

From the viewpoint of the tradition of economics, commodity price is the most important method that conveys information about quality. Generally speaking, commodities with high prices have high qualities. But in order for this proposition to hold, it is necessary in particular that a relatively large number of consumers are perfectly informed or that each consumer has relatively accurate information [Wolinsky (1983), Cooper and Ross (1984)]. When a relatively large number of consumers are perfectly informed, uninformed consumers acquire information about qualities through commodity prices. Thus the latter group receives external economies from the former as Salop and Stiglitz (1977) point out. Warranty or return systems, which are transaction conditions other than prices, may also convey information about qualities. But these systems are not free from moral hazard or adverse selection.

Shapiro (1983) emphasizes reputation formation on the part of the seller as a method of information production and dissemination. In the case of experience qualities, consumers may use the qualities sold in the past as indicators of present or future qualities. In this sense reputation formation is a type of signaling activity. A seller who wants to sell a high quality commodity must initially invest in his reputation by selling it at less than cost, because he cannot command the high price associated with high quality until his reputation is established. In order for this mechanism to work well, there must be free communication among consumers. But this model does not take account of consumers' incentives to communicate.

We note that each of the sellers and consumers is a producer of information in the display-search models. On the other hand, each seller is a producer and disseminator of information in the advertising models. In the prices-as-signals models many consumers have already obtained some amount of information somehow. Though how they have got it is not explained, they must have got it by search, experience, advertising, etc. Finally, in the reputations model each seller engages in signaling activity and consumers transmit the information they have obtained to other consumers. It is common in all of these models that there are a large number of producers (and disseminators) of information. If we take account of the fact that information is a (quasi-) public good, we can conjecture that these

methods of information production might involve a great amount of waste of resources that could be avoided by reducing the number of producers (and disseminators) of information.

A method of information production that seems more efficient than those mentioned above is reported in Devine and Marion (1979). Making use of the fact that information is a public good, comparative price information was publicly disseminated in Ottawa-Hull in 1974, and they studied its influence on the level and dispersion of prices and the level of consumer satisfaction. According to their study, the dispersion of prices across stores and chains narrowed, the average level of prices of the market dropped, and consumer satisfaction increased relative to the control market. Consumers transferred patronage to the lower-priced stores. Consumers indicated a willingness to pay 34¢ per week on average for the price comparison information. Estimated consumer benefits far exceeded the cost of the program.

Their study shows that there is demand for information in markets for consumer goods, that a public agency can meet this demand by allocating some resources for the production of information, and that public dissemination of price information brings about considerably favorable effects. Furthermore, their study implies that other methods of information production such as display-search, advertising, reputations etc. are incomplete, since these methods continued to exist during the experiment period and there was still demand for information.

The purpose of this paper is to examine theoretically the nature of information production and dissemination by a single agency facing social demand for price information. More precisely, this paper will answer the following questions:

- (a) How can we derive individual and aggregate (social) demand for price information?
- (b) What properties do these demand functions have?
- (c) Under what conditions does the agency find it worthwhile to produce information?
- (d) How is the allocation of resources for the production of information determined?
- (e) How is the price of information set?
- (f) Which produces better information, a government or a private firm?
- (g) How is the quality of produced information affected by several exogenous factors?

The recent changes in social conditions seem to make this type of centralized production of information more important. First, the rapid development of the computer and communication technology in the past few years must make this type of information production technologically easier. Second, as Devine and Marion note, markets for consumer goods are becoming increasingly complex, making the search and evaluation process more difficult. It is getting almost impossible for each consumer to be a specialist of every commodity. Third, as more women enter labor markets and per capita income increases, the opportunity cost of individual search gets larger.

Our main objective is to analyze the behavior of consumers and the single agency that produces and disseminates price information. This will be achieved at some cost: we will not consider explicitly the behavior of the sellers of commodities. Also for simplicity we restrict our analysis to comparative price information only. Information production about product qualities is very interesting, but it will be left for further analysis.

In section II we analyze the price search activities of consumers and then derive from this the individual and aggregate demand functions for price information. We answer there questions (a) and (b) from above. In Section III we consider the behavior of the producer and disseminator of information, which is either a private monopolist or a public agency.

This answers questions (c) through (e). In Section IV we examine how the quality of price information is affected by different institutions or social conditions. This enables us to answer questions (f) and (g). The last section provides some remarks on our analysis.

II. Demand for Price Information

Let $I \equiv [0, 1]$ denote the set of consumers each of whom is planning to buy one unit of the same commodity. The prices x of the commodity are distributed on the positive real line with a distribution function $F(\cdot)$. The probability density function of $F(\cdot)$ is denoted by $f(\cdot)$. Consumer $\alpha \in I$ has no information about where he can find particular prices, but he is assumed to know this distribution function. If he searches for prices by himself, he has to pay $c(\alpha)$ as his search cost each time he elicits a price. We assume that $c(\cdot)$ is a measurable function.

In relation to consumers, the role of the agency that produces price information is to collect information and transmit it to consumers for a nonnegative charge. The price information the agency has is made up of two components, i.e., a price of the commodity and its location. But we assume that when it 'displays' price information, it shows consumers only the first component and the price (or charge) for this information. The location of the displayed price of the commodity will be shown only to consumers who buy the information. We assume that consumers can observe without costs these two prices, i.e., the price of the commodity and the price of this price information. After observing these two prices, each consumer decides whether he buys the price information or whether he searches for prices by himself. He makes this decision so as to minimize his total expected costs of search and purchase.

It is well-known that a reservation price exists when a consumer engages by himself in sequential search. That is to say, consumer α has his reservation price ξ^α for which the following property holds: if he observes a price equal to or lower than ξ^α , he stops searching and buys the commodity for this price, but if he observes a price higher than ξ^α , he continues to search. The reservation price ξ^α is also the minimum expected total cost of search and purchase to consumer α and it satisfies the following equation¹:

$$(1) \quad c(\alpha) = \int_0^{\xi^\alpha} (\xi^\alpha - x)f(x)dx.$$

Differentiating (1) with respect to $c(\alpha)$, we have

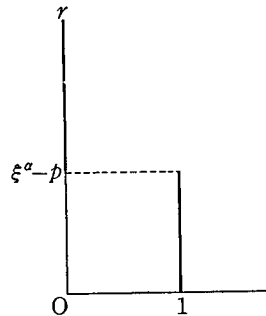
$$(2) \quad d\xi^\alpha/dc(\alpha) = 1/F(\xi^\alpha) > 0,$$

which implies that consumers with higher search costs have higher reservation prices.

Consider consumer α who has just observed a particular price p and its information price r displayed by the agency. Since ξ^α is α 's minimum expected costs of search and purchase, $\xi^\alpha - p$ is equal to the value of this information to α . If this value is no smaller than the information price, i.e., $\xi^\alpha - p \geq r$ or $\xi^\alpha \geq p + r$, he will buy this information and will not engage himself in search. On the other hand, if $\xi^\alpha - p < r$ or $\xi^\alpha < p + r$, he will not buy this information.

¹ For the derivation of (1) and a more detailed explanation of this type of search, see McCall (1970) or Lipman and McCall (1976).

FIGURE 1.



tion and will engage in price search by himself. This consideration implies that we have derived consumer α 's demand function for information, which is depicted in *Figure 1*. The vertical axis shows the price of information and the horizontal axis the demand for information. For convenience, we assume that the quantity of demand for information is equal to one if the consumer buys it and that it is equal to zero if he does not buy it.

We can interpret p , the location of which is known to the supplier of information, as the quality of information. The lower this p , the better the quality. With this we can derive some properties of the individual demand for information. *Figure 1* shows that the demand for information is a decreasing function of the information price r . On the other hand, if r is fixed, the demand increases as the quality of information gets better (as p decreases). If r and p are fixed, (2) implies that the demand increases as the search cost increases.²

We next consider the aggregate or social demand function for information. Define $B(r, p) \subset I$ as the following set:

$$(3) \quad B(r, p) = \{\alpha \in I: \xi^\alpha - p \geq r\}.$$

$B(r, p)$ is the set of consumers who buy the information with quality p for information price r . Since we can easily show

$$(4) \quad B(r, p) = \{\alpha \in I: c(\alpha) \geq \int_0^{p+r} (p+r-x)f(x)dx\}$$

and since $c(\cdot)$ is assumed to be measurable, $B(r, p)$ is a measurable set.³ Let $D(r, p)$ denote the aggregate demand for the information with information price r and quality level p . Then

$$(5) \quad D(r, p) = \mu[B(r, p)],$$

where μ denotes the Lebesgue measure. The aggregate demand function has properties similar to those of the individual demand function. (3) implies that $B(r_1, p) \supset B(r_2, p)$ for $r_1 \leq r_2$. Thus the sequence of sets $B(r_m, p)$ is nested for any monotone increasing sequence $\{r_m\}$. Therefore, $D(r, p)$ is a decreasing function of r . Similarly, it is decreasing in p . If

² In this paper we say a function $A(y)$ is decreasing in y if and only if $A(y_1) \geq A(y_2)$ for $y_1 \leq y_2$.

³ The left-hand side of the inequality in (4) is α 's marginal cost of search, while the right-hand side is the expected marginal return to his search given the information with price r and quality p .

the search costs of a set of consumers with a positive Lebesgue measure increase, the aggregate demand for information generally increases.

III. *Supply of Price Information*

We next consider the agency that produces price information and transmits it to consumers. We sometimes call it the producer or supplier of information in this paper. This producer is either a private monopolist that maximizes its own expected profit or a public agency that maximizes expected social welfare. As for the consumers we have assumed that they engage in sequential searches. But it must be realistic in the case of the supplier of information to assume that it adopts a fixed-sample-size search.⁴ A reason for this is that the supplier has a significant amount of fixed cost of search, the existence of which makes sequential search nonapplicable. Another reason is that when a firm engages in a large-scale search, the method of sequential search is too time-consuming. The supplier of information is also assumed to know the distribution $F(\cdot)$ of prices. Further, it must know the aggregate demand function for information, since it maximizes expected profit or expected social welfare.

We consider four types of costs in relation to the supplier of information. For both production and transmission of information there are fixed and variable costs. Let $g(n)$ represent the fixed (production and transmission) costs plus the variable production costs when the sample size is equal to n . We assume $g(\cdot)$ is increasing on the positive domain. The variable transmission cost, which will be expressed separately from $g(\cdot)$, is assumed to be proportional to the number of consumers to whom the information is transmitted. The proportion coefficient or the marginal transmission cost is denoted by $b > 0$.

In the previous section we assumed that the supplier of information displays a price of the commodity. We interpreted the price as the quality of information. The supplier can maximize its objective function by showing consumers the lowest of the prices it has observed by a fixed-sample-size search, because the better the quality of information, the larger the demand. Then using the order statistic, the probability density function of the quality of information that results from the random sampling of n times can be expressed as follows:

$$(6) \quad n(1 - F(p))^{n-1}f(p).$$

Once the quality p of information is determined as the lowest price of all the prices the producer has observed, the expected-profit-maximizing monopolist sets price (or charge) r of this price information so as to

$$(7) \quad \underset{r}{\text{maximize}} (r - b)D(r, p).$$

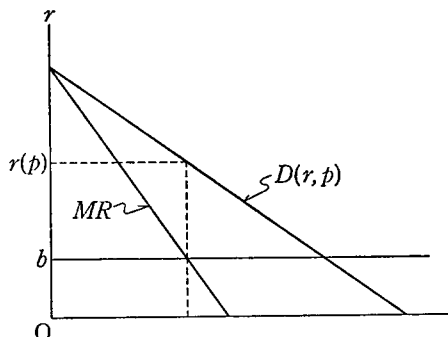
Assuming that D is differentiable, we get the first-order condition for (7) as

$$(8) \quad D(r, p) + (r - b)D_r(r, p) = 0,$$

where D_r denotes the partial derivative of D with respect to its first argument. The price of the price information determined by (8) obviously depends on the quality p of the information.

⁴ For the theory of fixed-sample-size search, see Stigler (1961).

FIGURE 2.



So let $r(p)$ denote the price the monopolist chooses according to (8). Figure 2 illustrates this price setting behavior in a fashion slightly different from (7).

How is the sample size n determined? When the quality of information is p , the maximum revenue net of the variable transmission cost is equal to $(r(p) - b)D(r(p), p)$. Thus the expected profit π_1 of the monopolist at sample size n can be expressed in consideration of (6) as

$$(9) \quad \pi_1(n) = \int_0^{\infty} (r(p) - b)D(r(p), p)n(1 - F(p))^{n-1}f(p)dp - g(n).$$

The monopolist chooses n so as to maximize (9). We simplify this by defining

$$(10) \quad R(p) = (r(p) - b)D(r(p), p).$$

Then using (10) and applying integration by parts to (9), we have

$$(11) \quad \pi_1(n) = R(0) + \int_0^{\infty} (1 - F(p))^n R'(p) dp - g(n).$$

This is easier to manipulate than (9).

The sample size n to be actually chosen by the monopolist is a nonnegative integer, but the computation becomes easier if we regard it as a nonnegative real number. This is true if (11), with n regarded as a nonnegative real number, has only one local maximum, because the monopolist's optimal sample size in this case becomes one of the following four: if the nonnegative real number that maximizes (11) is actually an integer, it is the optimal sample size when the expected profit is nonnegative; if not, the optimal sample size is either of the two integers adjacent to the maximizing real number when the expected profit at either sample size is nonnegative; if the expected profit is negative at any of the above sample size, then the optimal size is zero. Because of this we regard n as a nonnegative real number when (11) has only one local maximum. In this way we avoid all insignificant complications.

Differentiating (11), we get the first-order condition for the optimal sample size:

$$(12) \quad \pi_1'(n) = \int_0^{\infty} (1 - F(p))^n [\log(1 - F(p))] R'(p) dp - g'(n) = 0.$$

The second-order condition is given by

$$(13) \quad \pi_1''(n) = \int_0^\infty (1-F(p))^n [\log(1-F(p))]^2 R'(p) dp - g''(n) < 0.$$

To see if this is satisfied, we compute $R'(p)$:

$$(14) \quad R'(p) = r'(p)[D(r(p), p) + (r(p) - b)D_r(r(p), p)] + (r(p) - b)D_p(r(p), p) \\ = (r(p) - b)D_p(r(p), p) < 0,$$

where D_p denotes the partial derivative of D with respect to its second argument. The second equality in (14) follows from (8) and the inequality is due to the fact that the demand for information decreases as quality gets worse. Applying (14) to (13), we see that the second-order condition is satisfied if $g'' \geq 0$, but that this is not necessary. Therefore, we assume that (13) holds for all nonnegative n . This also means that $\pi_1(\cdot)$ is concave and has only one local maximum. In the light of the above argument, the essence of our analysis will not change even if n is regarded as a nonnegative real number.

Next we consider the case in which a public agency produces information to maximize expected social welfare. Once a piece of price information is produced, the agency is assumed to transmit it to all of the consumers who are willing to pay the transmission costs. So let $W(p)$ denote the aggregate value net of the variable transmission costs of the information with quality p , i.e.,

$$(15) \quad W(p) = \int_b^\infty D(r, p) dr.$$

Since $D(r, p)$ is decreasing in p , $W'(p) < 0$. The net expected social welfare π_2 that results from the production of information by this public agency is then expressed as

$$(16) \quad \pi_2(n) = \int_0^\infty W(p)n(1-F(p))^{n-1}f(p)dp - g(n).$$

The public agency chooses its sample size n so as to maximize (16). Here we have assumed that the price of information is b , the marginal transmission cost of information, and that other costs, $g(n)$, are financed by tax or something similar. Applying integration by parts to (16), we have

$$(17) \quad \pi_2(n) = W(0) + \int_0^\infty (1-F(p))^n W'(p) dp - g(n).$$

The first-order condition for the maximization is

$$(18) \quad \pi_2'(n) = \int_0^\infty (1-F(p))^n [\log(1-F(p))] W'(p) dp - g'(n) = 0$$

and the second-order condition is given by

$$(19) \quad \pi_2''(n) = \int_0^\infty (1-F(p))^n [\log(1-F(p))]^2 W'(p) dp - g''(n) < 0,$$

which is satisfied if $g'' \geq 0$, though this is not necessary. As before we assume that π_2 is concave, which is true if $g'' \geq 0$, and thus that it has only one local maximum.

The sample size that satisfies the first-order condition when the second-order condition is satisfied is not necessarily the optimal one in either the monopolist case or the public agency case. If the expected profit or the expected social welfare is negative, production of information will not be undertaken. Thus it is natural to ask in what cases price information will be produced. It is easy to answer this question in our framework. There are four major answers.

The first is the case in which consumers' search costs are large. Since the demand for information is large in this case, the first term in (9) or (16) is large, so the expected profit or social welfare corresponding to the sample size that satisfies the first-order condition becomes positive. Then what factors lead to large search costs? The most important factor is an increase in the opportunity cost of search due to increases in consumers' incomes or in the rate of women's participation in labor markets. The second is the case in which the number of consumers is large. Because we have considered a measure space of consumers, the cost function $g(\cdot)$ represents the cost per consumer. Thus the larger the number of consumers in the information market, the smaller $g(\cdot)$ or the second term in (9) or (16). This implies that a large information market makes production of information beneficial. This result corresponds in our model to the important characteristic of information that information does not depreciate after the consumption of it.⁵ The third is the case in which $g(\cdot)$ is small for a technological reason. The fourth is the case in which the marginal transmission cost b is small. This obviously makes the first term of (9) or (16) large.

IV. *Quality of Price Information*

According to the probability density function (6), the larger the sample size chosen by the supplier of information, the better the quality of information is likely to be. We see in this section what factors tend to result in better quality of supplied information.

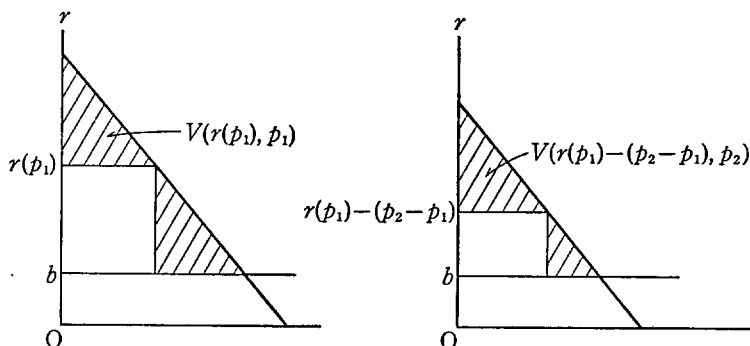
First we compare the private monopolist with the public agency, and examine which tends to supply better information. We show that the monopolist that maximizes expected profit tends to produce inferior information than the public agency that maximizes expected social welfare. We can show this by proving that the former's sample size is smaller than the latter's.

As in the previous section, we assume that the second order conditions (13) and (19) are satisfied for all n and treat n as a nonnegative real number. Since the sample size of each of the monopolist and the public agency is determined by (12) and (18) respectively, and both $\pi_1'(\cdot)$ and $\pi_2'(\cdot)$ are decreasing functions, we have only to show the following inequality for the above purpose:

$$(20) \quad \pi_2'(n) - \pi_1'(n) = \int_0^{\infty} (1 - F(p))^n [\log(1 - F(p))] [W'(p) - R'(p)] dp > 0$$

⁵ We assume that each seller can sell any amount of the commodity for the same unit price. This simplifying assumption is pretty common in the economics of information (see e.g. Notes 9 and 11 in Salop and Stiglitz (1977)).

FIGURE 3.



for all $n \geq 0$. This clearly holds when $W'(p) - R'(p) < 0$. So we define

$$(21) \quad \phi(p) \equiv W(p) - R(p)$$

and show that $\phi(p)$ is decreasing. Consider an arbitrary pair of prices p_1 and p_2 such that $p_1 < p_2$. Since

$$\begin{aligned} B(r, p_1) &= \{\alpha \in I: \xi^\alpha - p_1 \geq r\} \\ &= \{\alpha \in I: \xi^\alpha - p_2 \geq r + p_1 - p_2\} \\ &= B(r + p_1 - p_2, p_2), \end{aligned}$$

the aggregate demand for the information with quality p_2 can be obtained by shifting downward that for the information with quality p_1 by $(p_2 - p_1)$.

We define $V(r, p)$ as $W(p)$ minus the revenue (net of the variable transmission costs) of the monopolist which sells the information with quality p for price r (see Figure 3). If the monopolist sets the price that maximizes its profit, then $V(r(p), p) = \phi(p)$ by (21), but at other information prices $V(r, p) \geq \phi(p)$. Now suppose the monopolist charges $r(p_1) - (p_2 - p_1)$ for the information with quality p_2 , i.e., suppose it charges the price lower than $r(p_1)$ by $p_2 - p_1$. Then the relation of parallel shift implies

$$(22) \quad V(r(p_1) - (p_2 - p_1), p_2) < V(r(p_1), p_1),$$

which is illustrated in Figure 3. Since $r(p_2)$ maximizes the monopolist's revenue when the quality of information is p_2 , we have

$$(23) \quad V(r(p_2), p_2) \leq V(r(p_1) - (p_2 - p_1), p_2).$$

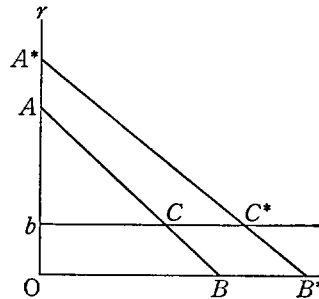
(22) and (23) together imply

$$(24) \quad V(r(p_2), p_2) < V(r(p_1), p_1),$$

proving that $\phi(p)$ is decreasing. As we mentioned above, this implies that the monopolist's sample size is smaller than the public agency's and thus the former tends to produce inferior information than the latter.

The second factor that affects the quality of information is the search costs of consumers. We can show in most cases that the higher the search costs, the better the quality of information. Since the sample size of the public agency is determined by equation (18) and $\pi_2'(\cdot)$ is

FIGURE 4.



decreasing, we want to show that $\pi_2'(\cdot)$ shifts upward as the search costs increase. Suppose the search costs of almost every consumer increase.⁶ Then the demand curve for information shifts upward because of its property discussed in Section II. We illustrate this in *Figure 4*, where AB is the aggregate demand for information before the search costs increase and A^*B^* is that after they have increased. In view of (15), we define

$$W^*(p) = W(p) + w(p),$$

where $W(p)$ is equal to the area of AbC and $w(p)$ to that of A^*ACC^* . Since the two demand curves follow parallel shifts to the bottom for an increase in p , as was discussed previously, we have $w'(p) < 0$. Therefore,

$$(25) \quad W^{*'}(p) = W'(p) + w'(p) < W'(p).$$

Equation (18) and inequality (25) together imply that $\pi_2'(\cdot)$ shifts upward as the search costs increase.⁷

The general case in which the monopolist supplies information and search costs increase is difficult to manipulate, because the marginal revenue curve in *Figure 2* may be intricately transformed by an increase in search costs of consumers. But if the whole of the new marginal revenue curve shifts above the old one,⁸ we can obtain the same results as those of the case of the public agency by comparing the marginal revenue curves in the monopolist case to the demand curves in the public agency case.

There are a few other factors that affect the quality of information. Equations (12) and (18) show that the smaller $g'(\cdot)$, the larger the sample sizes. The marginal cost of information production $g'(\cdot)$ gets smaller either when the information market gets larger or when the information production technology improves. The marginal transmission cost of information b also affects the quality of information. This can be easily seen in the case of the public agency. Differentiating (15) with respect to p and again with respect to b , we have

$$(26) \quad \partial W'(p) / \partial b = -D_p(b, p) > 0.$$

⁶ 'Almost every consumer' stands for all the consumers but a set of consumers with measure zero.

⁷ If we assume that the search costs of only a set of consumers with a positive measure increase, then the strict inequality in (25) does not necessarily hold. But a procedure similar to that of the proof in the text will show that an increase in the search costs of some consumers never leads to smaller sample size as far as the other consumers' search costs remain the same.

⁸ This can happen when demand functions are linear, though it is not the only case.

Equation (18) and inequality (26) together imply that the smaller the marginal transmission cost of information, the larger the sample size.⁹

V. *Concluding Remarks*

In this paper, we have derived consumers' demand functions for information and analyzed how a private monopolist or a public agency supplies information. In this final section we want to make some remarks about our analysis. The first remark is about the assumption that there is only one supplier of information in our model. Information usually has the property that many people can simultaneously consume it without changing its quality. Thus the larger the number of buyers of information, the smaller the production cost of information per buyer. Therefore, it is not conceivable that the information market is competitive, and we think the above assumption is appropriate.¹⁰

The second remark is also related to the property of information. Our proposition that a public agency is likely to supply better information can be supported by another fact. Some consumers might acquire information from other consumers who got it from the original supplier. This kind of leakage of information prevents the private monopolist supplier from recovering the costs of information production that meets the real demand for information. This implies that the monopolist's expenditure for information production is likely to get smaller than that in the theoretical model with no leakage and that the quality of information tends to be much worse than that of a public agency. Leakage is not a problem in the case of public provision of information, since the buyers of information pay only the marginal transmission costs and all the other costs are financed by tax or other sources.

Third, the assumption that the loss of the public agency that maximizes social welfare is financed by tax or other sources is less unnatural than it might appear. As Salop and Stiglitz (1977), Varian (1980), and Cooper and Ross (1984) note, uninformed consumers are likely to receive external economies from informed consumers in the sense that the latter can buy commodities at low prices without sufficient search. The markets in these models have actually no means to compensate the informed consumers for their valuable knowledge. Thus there is a good ground for the idea that the public agency should be subsidized by tax or other sources in our model.

Fourth, we did not consider explicitly the behavior of the sellers of the commodity to simplify our analysis. Though one might regard this approach as incomplete, we think that to get an equilibrium distribution of prices is not all. We got our results by avoiding restrictive assumptions and showing the behavior of the information supplier in a simple form. Further, because our method does not depend on the shape of the distribution function of prices, our model also applies even to an equilibrium distribution of prices.

Finally, though our analysis has been restricted to the case of a pure supplier of price information, there is a possibility of extending it to other cases. Using a similar idea, we might gain some insight into the behavior of wholesalers and retailers, because they actually

⁹ The monopolist case is again difficult. This is partly because we have to determine the sign of the cross derivative $D_{p,p'}$ when calculating $\partial R'(p)/\partial b$ in (14).

¹⁰ This should be rigorously understood. A competitive information market here implies a market where several agents supply price information about the same commodity.

sell information as well as commodities. Other cases that might be interesting topics for further study are realty dealers, travel agencies, employment agencies, and trade companies. It is interesting to note that the recent development of the computer and communication technology is very likely to have a serious influence on all of these industries.

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